

PATENT
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**RESET MODE INDICATION FOR AN INTEGRATED CIRCUIT USING A
NON-DEDICATED PIN**

by

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BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to an integrated circuit technique, and, more particularly, to a technique for resetting an integrated circuit. More specifically, the present invention relates to resetting an integrated circuit using a non-dedicated reset pin.

Description of Related Art

[0002] An integrated circuit is typically provided on a chip having a number of pins. A reset feature generally needs to be provided for the integrated circuit. One easy way to provide such a reset feature is to designate one of the chip pins as a dedicated reset pin. **Figure 1** shows an integrated circuit **100** according to the prior art. Integrated circuit has a number of pins **102, 104, 106, 108, 110, 112, 114, 116, 118, 120** and also a designated reset pin **RESET**. In one example, the designated reset pin **RESET** is toggled between a high value, which indicates that the chip is to reset, and a low value, which indicates the chip is to operate in a normal mode.

[0003] Lowering the pin count of a chip is generally desirable. For example, a lower pin count helps lower the manufacturing costs of a chip and may make the chip more marketable due to the lower number of pin interfaces. In lowering the pin count of a chip, the designated reset pin is often omitted. When the designated reset pin is omitted to reduce pin count, another way for resetting the chip needs to be provided.

[0004] One such alternative way for indicating chip reset is a power-on reset. A power-on reset generally involves the chip detecting whether a power supply voltage level at a power supply pin has exceeded a certain threshold. When the power supply voltage level has exceeded the certain threshold, then the chip has been powered on and the chip needs to be reset. Otherwise, the chip operates in the normal manner. However, the problem

with a power-on reset is that the power supply may not have completely turned on or may not have been stable when it turned on. In these situations, the chip may not have reset at the appropriate time when the power-on occurred, which may cause the chip to cease operating or cause other
5 operating errors. For testing of a chip, it is desirable to control the exact time of when the chip leaves reset, and such control is difficult to obtain with a power-on reset.

[0005] Thus, the present invention recognizes the desire and need for providing a way for resetting an integrated circuit without the use of a
10 dedicated reset pin. The present invention further recognizes the desire and need to reset an integrated circuit, which avoids using a power-on reset. The present invention also recognizes the desire and need to provide a way for resetting an integrated circuit without adding additional pins. The present invention overcomes the problems and disadvantages in accordance with the
15 prior art.

Summary of the Invention

[0006] An integrated circuit has a circuitry and pins coupled to the circuitry. One of the pins is a non-dedicated reset pin having a pin signal that is set at a level outside of a normal range for the pin signal so that the
20 integrated circuit is indicated to reset.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as a preferred mode of use, further objects and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

[0008] **Figure 1** is a block diagram of an exemplary integrated circuit having a number of pins and a designated reset pin according to the prior art;

10 [0009] **Figure 2** is a block diagram of an exemplary embodiment of a digital-to-analog converter (DAC) utilizing an analog pin to indicate the DAC to reset according to the present invention;

[0010] **Figure 3** is a block diagram of another exemplary embodiment of a digital-to-analog converter (DAC) utilizing another analog pin to indicate the DAC to reset according to the present invention; and

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[0011] **Figure 4** is a flow chart diagram of an algorithm for using the non-designated reset pin to indicate whether a chip is to operate in the normal mode or in the reset mode.

DETAILED DESCRIPTION OF THE INVENTION

[0012] An integrated circuit has a circuitry and pins coupled to the circuitry. One of the pins is a non-dedicated reset pin having a pin signal that is set at a level outside of a normal range for the pin signal so that the integrated circuit is indicated to reset.

[0013] With reference now to **Figure 2**, an exemplary embodiment of a digital-to-analog converter (DAC) **200** utilizing an analog pin to indicate DAC **200** to reset is shown according to the present invention. DAC **200** has a number of pins, such as serial audio data input pin **SDIN**; de-emphasis/external serial clock input pin **DEM/SCLK**; left right clock pin **LRCK**; master clock pin **MCLK**; quiescent voltage pin **VQ**; positive voltage reference pin **FILT+**; left channel analog output pin **AOUTL**; ground pin **GND**; analog power pin **VA**; and right channel analog output pin **AOUTR**.

[0014] Pin **SDIN** is utilized for inputting two's complement serial audio data into DAC **200**. Pin **DEM/SCLK** is utilized for either de-emphasis filter control or external serial clock input for DAC **200**. Pin **LRCK** is utilized for determining whether the left or right channel is currently active on the serial audio data line. Pin **MCLK** is utilized to provide the clock source for the delta-sigma modulator and digital filters of DAC **200**. Pin **VQ** is utilized to provide a filter connection for the internal quiescent voltage of DAC **200**. Pin **FILT+** is utilized for the positive reference voltage for the internal sampling circuits. Pin **AOUTL** is utilized to provide the full-scale analog output level for the left channel of DAC **200**. Pin **GND** is utilized for the ground reference. Pin **VA** is utilized to provide the positive power for the analog and digital sections of DAC **200**. Pin **AOUTR** is utilized to provide the full-scale analog output level for the right channel of DAC **200**.

[0015] DAC **200** further has a de-emphasis filter block **101** coupled to serial audio data input pin **SDIN** and a serial interface block **102** also coupled to serial audio data input pin **SDIN**. DAC **200** has two channels: a right channel and a left channel. The right channel comprises interpolation filter

104A, multibit delta-sigma modulator **106A**, and a switched-capacitor digital-to-analog converter (DAC) unit and filter **108A** coupled together in series as shown in **Figure 2**. The right channel receives the right-channel digital signals from serial interface block **102**. Interpolation filter **104A** interpolates the right-channel digital signals, and multibit delta-sigma modulator **106A** modulates the interpolated digital signals. Switched-capacitor DAC unit and filter **108A** converts the modulated digital signals into analog signals and filters the analog signals for output through right channel analog output pin **AOUTR**.

10 [0016] The left channel comprises interpolation filter **104B**, multibit delta-sigma modulator **106B**, and a switched-capacitor digital-to-analog (DAC) converter unit and filter **108B** coupled together in series as shown in **Figure 2**. The left channel receives the left-channel digital signals from serial interface block **102**. Interpolation filter **104B** interpolates the left-channel digital signals, and multibit delta-sigma modulator **106B** modulates the interpolated digital signals. Switched-capacitor DAC unit and filter **108B** converts the modulated digital signals into analog signals and filters the analog signals for output through left channel analog output pin **AOUTL**.

20 [0017] In this embodiment of **Figure 2**, the quiescent voltage pin **VQ** is the analog pin that is the non-dedicated reset pin utilized for indicating reset of DAC **200**. A voltage divider having two resistors **R1** and **R2** in series is coupled within the DAC **200** between analog power pin **VA** and ground pin **GND**. Analog power pin **VA** connects to a positive power supply to operate the analog and digital sections of DAC **200**. Ground pin **GND** connects to a ground. Quiescent voltage pin **VQ** is coupled to a node between the two resistors **R1** and **R2** of the voltage divider as shown in **Figure 2**. Switch **202** switchingly couples quiescent voltage pin **VQ** to a capacitor **C1** so that DAC **200** is indicated to operate in a normal operational mode. Capacitor **C1**, in turn, is coupled to ground. When pin **VQ** is coupled to capacitor **C1**, pin **VQ** is utilized to provide the filter connection for the internal quiescent voltage in the normal operational mode. In one example, the internal quiescent voltage may

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be half of a supply voltage. Switch **202** alternatively switches and couples quiescent voltage pin **VQ** directly to ground so that DAC **200** is indicated to reset. In this case, the voltage level applied at pin **VQ** is forced below the normal range for the internal quiescent voltage indicating that DAC **200** is to reset, and DAC **200** accordingly resets.

[0018] Referring now to **Figure 3**, another exemplary embodiment of a digital-to-analog converter (DAC) **300** utilizing another analog pin to indicate DAC **300** to reset is shown according to the present invention. DAC **300** is identical to DAC **200** except that the analog pin utilized for reset in this case is the positive voltage reference pin **FILT+** instead of the quiescent voltage pin **VQ** as used by DAC **200**. A resistor **R3** is coupled within DAC **300** between analog power pin **VA** and positive voltage reference pin **FILT+**. Analog power pin **VA** connects to a positive power supply to operate the analog and digital sections of DAC **300**.

[0019] Switch **302** switchingly couples positive voltage reference pin **FILT+** to a capacitor **C2** so that DAC **300** is indicated to operate in a normal operational mode. Capacitor **C2**, in turn, is coupled to ground. When pin **FILT+** is coupled to capacitor **C2**, pin **FILT+** is utilized to provide the positive reference voltage for the internal sampling circuits during the normal operational mode of DAC **300**. Switch **302** alternatively switches and couples positive voltage reference pin **FILT+** directly to ground so that DAC **300** is indicated to reset. In this case, the voltage level applied at pin **FILT+** is forced below the normal range for the positive reference voltage indicating that DAC **300** is to reset, and DAC **300** accordingly resets.

[0020] With reference now to **Figure 4**, a general algorithm **400** for using a non-designated reset pin to indicate whether a chip or integrated circuit is to operate in a normal mode and a reset mode is shown. A state machine may implement algorithm **400** for an integrated circuit or chip. Algorithm **400** includes a decision block **404**. Decision block **404** shows a determination as to whether the voltage at the non-designated reset pin is outside of the normal

operating range. If the voltage at the non-designated reset pin is not outside of the normal operating range, then algorithm 400 proceeds from decision block 404 to block 406. Block 406 depicts operating the chip in the normal mode. After block 406, algorithm 400 loops back before decision block 404 and continues to detect voltage levels at the non-designated reset pin. On the other hand, if the voltage at the non-designated reset pin is outside of the normal operating range at decision block 404, then algorithm 400 instead proceeds from decision block 404 to block 408. Block 408 illustrates operating the chip in the reset mode. After block 408, algorithm 400 then loops back before decision block 404 and continues to detect voltage levels at the non-designated reset pin. Thus, since the steps of algorithm 400 are continuously repeated, algorithm 400 is a continuous detection process for detecting whether the integrated circuit or chip is to operate in the normal mode or to be put into a reset mode.

[0021] Thus, the present invention provides a way for resetting an integrated circuit without the use of a dedicated reset pin. The present invention further resets an integrated circuit by using a non-dedicated reset pin and avoids using a power-on reset. The present invention also provides a way for resetting an integrated circuit without adding additional pins. The present invention overcomes the problems and disadvantages in accordance with the prior art.

[0022] While the invention has been particularly shown and described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention.